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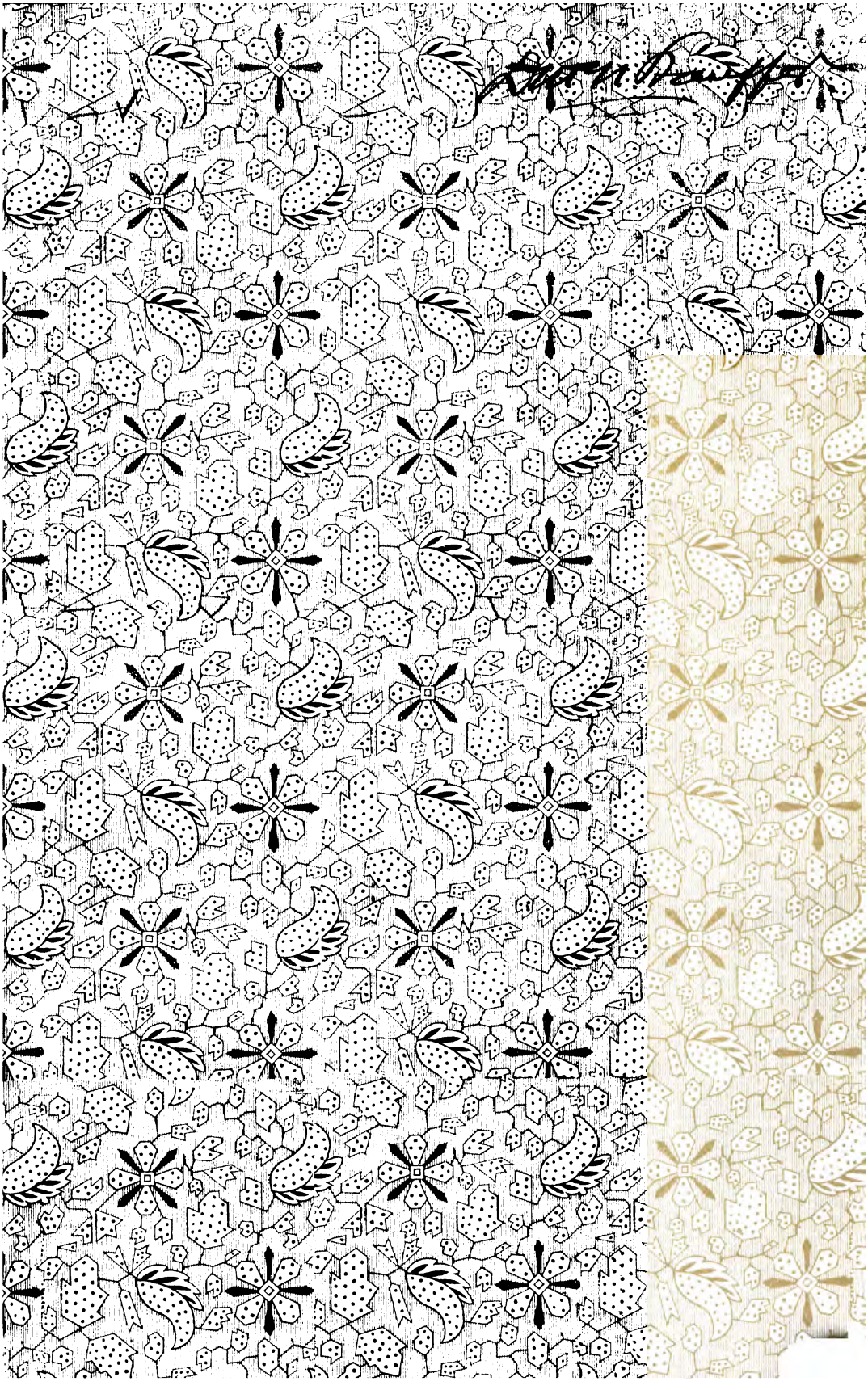

Cable Traction Systems

OF

The Rapid Transit Cable Company,

NEW YORK.

OFFICERS OF THE COMPANY:

President,

CORNELIUS TIERS.

Vice-President,

ANDREW BRYSON,

Formerly Chief Engineer of the Kings County Elevated R. R., Brooklyn, N. Y.

Secretary and Treasurer,

HEYWARD H. McALLISTER.

Chief Engineer,

JOHN H. PENDLETON,

Civil and Mechanical Engineer.

Consulting Engineers,

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ROBT. I. SLOAN. THOS. L. SNEAD. THOS. SWINYARD.
R. DUNCAN HARRIS. CORNELIUS TIERS.

OFFICE, 12 BROADWAY, NEW YORK.

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The Rapid Transit Cable Company's Cable Traction Systems.

(PATENTED.)

TRANSPORTATION in its various adaptations is a subject of general interest, and in the requirement of rapid transit in cities it has become a universal consideration and a most serious problem.

The fundamental basis of transportation in cities, towns, and suburbs is the *railway*,—on the *surface*, *underground*, or *elevated*; but that which must be the solution of the problem, by making the respective systems what they should be, as recognized by railway managers in point of economy and general efficiency, and demanded by the public as a matter of accommodation and convenience, is the MOTIVE POWER. This is accomplished

in the Cable Traction Systems of the Rapid Transit Cable Company.

We respectfully submit the following for the reflection of those interested in city and suburban transportation, and we shall be pleased to furnish proper information to those contemplating the construction of railways for that purpose.

ELEVATED RAILWAYS.

OBJECTIONS TO THE PRESENT METHOD OF OPERATION.

FROM the elevated railways the public expects and demands the highest efficiency; all trains must be moved with the greatest regularity, otherwise tedious delays occur, not only affecting one train but extending over the entire system.

The method of locomotive traction now in use is expensive, the returns per pound of coal being only about one-third of that which can be obtained by concentrating the power and using the best form of stationary engines; the number of men required to care for a large number of separate pieces of machinery is much greater than for concentrated power; to provide the necessary tractive force the locomotive must have heavy loads concentrated on its driving-wheels; this brings severe strains on the structure, and causes the maintenance account to be much greater than it would be were a system used which is not dependent on adhesion; grades must be as

easy as possible, for they limit the capacity of the road and in consequence the structure is often so high above the surface that many people who would otherwise be patrons are deterred by the long flights of stairs; each train being independent, there is no compensation of power by trains going down hill assisting those bound in the opposite direction, which is an exceedingly important factor in the economy of operation. Smoke, escaping steam, and noxious gases, with falling cinders, grease and dirty hot water, and, at times, burning coals, are not only offensive, but dangerous to people living and doing business along the line, and it is safe to say that the greater part of the many claims for damages brought by adjoin ing property-owners are due to these ever-present nuisances; showers of fine half-burned scales from the lumps of coal which expand instantly when thrown on a hot fire, are familiar to all elevated-railway travellers, who are often seriously injured by them.

The locomotives in use on the Manhattan road are of special design and very efficient, generating 500 to 600 H. P. per 100 lbs. of coal, and moving maximum trains of 100 tons in addition to their own weight of 47,000 lbs.; and, although the cost of operation is greatly increased by heavy taxes and legal expenses, the cost of the motive power alone is 42 per cent of the aggregate, which is about 10 per cent higher, proportionally, than

on horse-car lines, although they are generally considered to be the most expensive type of railway.

The loss of power in driving the locomotive itself is from 10 to 15 per cent of its total pulling-force; and there is also loss in running-time, because it takes more time and power to attain full speed when the resistance of the train is increased 30 per cent by the addition of the locomotive, and there is a corresponding loss of time in stopping for the same reason, requiring an earlier application of the train-brakes and a longer distance to stop in.

At the time of starting, when the greatest power is required to quickly overcome the inertia of the heavy train, the locomotive can only develop its minimum power.

Another important item is waste of fuel. On the Manhattan Elevated Railway coal averages over $4 per ton on board the engines; and this expensive fuel, costing $730,000 per year, is burned under the worst conditions for economy, i.e. on an inadequate grate area, under a forced draught, with a short chimney, and at a high rate of combustion; a clean bright fire must be maintained at the expense of partly burned fuel, there being enough carbon left in the refuse, when screened and washed, to run a stationary boiler. It is a good locomotive boiler that will furnish 700 lbs. of dry steam with 100 lbs. of coal burned on the grate; whereas burned at a slow rate

of combustion, with a tall chimney and a properly designed boiler, using the steam in a high-speed, compound, condensing engine with automatic cut-off valves, we may expect to realize from 900 to 1200 lbs., and to furnish one horse-power with less than 2½ lbs. of coal, in place of from 5 to 7 lbs. required by the locomotives. There is also the cost of caring for and maintaining fires when the engines are standing idle, and a great loss of heat due to radiation, especially in a winter storm, when the whole machine is moving rapidly in a cold gale of wind, and every rain-drop rolling off the hot boiler or the cylinder jackets absorbs a portion of their heat. Even on a summer's day this cooling action is produced by the motion of the machine causing a strong current of air which is equivalent to a natural gale of the same velocity.

As regards maintenance, there are many more parts to be kept in repair, and all engineers know that locomotive grates, fire-boxes, tubes, bearings, rods, valve-motions, and other parts wear out more quickly than the corresponding parts of stationary boilers and engines. In one case we may have 300 boilers with their double engines called locomotives careering over frogs, switches, and rail-joints exposed to cold, wind, rain, grit, and dirt; in the other there would be 20 large plants, their engines reposing quietly on fixed, rigid, and level foundations, in a warm atmosphere, free from grit and dirt.

It is self-evident that to keep in motion 300 locomotives weighing over 7000 tons—all of which is non-paying load—requires not only more power, but entails more wear, friction and hard usage, greater cost of repairs, more shop-room, and more skilled labor.

THE CABLE.

CABLE railways have, where properly constructed, given great satisfaction, and the system has steadily grown in favor since its introduction on Clay Street, San Francisco, Cal., in 1873; but the best example of a line of this character for heavy service is to be found on the New York and Brooklyn Bridge,* over which passengers were first taken September 24, 1883, from which time to May 1, 1888, 91,376,778 passengers were carried, and the delays to traffic due to the cable system amounted in the aggregate to but 20 hours and 46 minutes, an average per month of only 23½ minutes, or *less than one minute* per day. This, it must be remembered, on a road about 1⅛ miles long, having 3¼ per cent grades, operating trains at from 4-minute to 1½-minute intervals (since reduced to 1¼ minutes) with a speed of 10 miles per hour. It may be doubted if any road in this or any other country can show a better record. The grips there used consist of two pairs of packed wheels or rollers, set in frames oppo-

* The writer is indebted for the facts here given regarding the New York and Brooklyn Bridge to a very valuable paper read before the American Society of Civil Engineers by Mr. G. Leverich, M. Am. Soc. C. E. Transactions, March, 1888.

site each other: between these is a pair of solid gripping-jaws; the cable is first brought into contact with the rollers, after which the jaws come into action and serve as a lock. This grip has these great disadvantages, however: Inability to take hold of the cable except at certain fixed points, or to operate on curved tracks, and too small contact of the rollers with the cable, and to exert the requisite gripping-power on the cable it must be applied with great force, especially at the time of starting the train, when the greatest power is required: this "pinch" on the cable is destructive to the strands, and the solid jaws are brought into action too quickly; yet the first cable was in continuous use from the opening of the railway to November 7, 1886, and the second was still serviceable in April, 1888, while the roller packing gives a service of 20,000 miles.

But grips on each car, and ten miles per hour, regardless of its inapplicability to curved lines or inability to take hold of the cable, would not answer for elevated railways, and a cable moving at a greater speed would, if brought into contact with such rollers, very soon destroy the packing.

1. Is it then possible to run a cable at sufficient speed to provide *rapid transit?*

2. Is it possible, provided the required speed can with

safety be obtained, to grasp the cable with any effective gripping-device without great destruction to either cable or grip, or both?

3. Can a sufficiently powerful grip be devised to haul the heavy trains in use on elevated railways, provided the ability to grasp the cable is demonstrated?

4. Will any saving be effected in operating expenses by substituting cable and stationary engines for the system now in use?

To each and all of these questions we reply in the affirmative, and, taking them in their order, will endeavor to prove our position.

1. The present elevated railways in New York are operated at an average speed, including stops, of 12.18 miles per hour or 17.86 feet per second; express trains, 18.23 miles per hour or 26.74 feet per second; allowing for station stops, the maximum speed will be under 20.5 miles per hour or 29.9 feet per second.

The speed at which a cable for the transmission of power can be run may be determined by the liability of the pulleys to burst under the action of centrifugal force, and this *safe* speed is determined by Prof. Unwin, for cast-iron of 4500 lbs. per square inch tensile strength, to be 215 feet per second; so that if we adopt 25 miles per hour as the desired velocity, which is nearly one-fourth

greater than now used, we shall have for our working speed 36.66 feet per second, or about $\frac{1}{6}$ of the safe limit for *cast-iron* pulleys.

Hence there can be no question as to speed.

2. To one familiar only with the cable grips at present in use it is but natural that this second question should cause considerable apprehension, for there is not one which could be successfully used for such velocity as has been above assumed. But the Rapid Transit Cable Company have had this question of providing a gripping-apparatus applicable for heavy trains and high velocity constantly in view, and their experiments and labors have been largely devoted to overcoming the difficulties encountered; in fact, it may be said to have been a *sine qua non*, and they are at last prepared to claim a successful solution of the problem. Their grip for such service as is now under consideration is placed on a separate truck or car, and hauls the train as a locomotive; but instead of weighing $23\frac{1}{2}$ tons, concentrated as largely as possible on four driving-wheels, it weighs less than 10 tons; it is supplied with pumping-cylinders to provide compressed air or vacuum for operating train-brakes, and for moving itself about yards or switching from one track to another Curves of any radii which are practicable for any other motive power are passed with equal facility, and the cable can be picked up at any and all points on the line.

It is arranged for duplicate cables, as is also the driving-machinery, so that in case of any accident the idle cable may be picked up without a delay exceeding five minutes wherever the trains may be. The gripping-device gives a very long contact, thus reducing the unit pressure on the cable for a given weight of train. The gripping-surface is of leather, and to still further protect the parts in contact from excessive wear a very simple device *sets the movable gripping-parts into motion automatically before they are brought into contact with the moving cable*; thus that which *in all other grips* would be speedily cut out by the cable is in this case preserved, and little or no cutting can take place. When the parts are moving *at the cable speed* the pressure is applied, the grip-brakes are brought into action, and the pulling-power of the cable gradually overcomes the inertia of the train.

This is a most important feature of our invention not possessed by any grip at present known, and hence it is the *only grip* by which high speed, with heavy rolling-stock, can be operated successfully. All the advantages claimed for both "roller" and "solid" grips are here combined, while the disadvantages of too small contact in the one, and excessive wear on cable and grip in the other, are entirely avoided.

3. In answer to the third question it is sufficient to state that the length of the gripping-surface is 60 inches, which,

used with a cable of 1¾ inches diameter, and assuming only three-fourths of the periphery to be subjected to the gripping-pressure, will give an available area of 246 square inches. The friction of leather on a cable may safely be taken as 0.6 of the pressure applied, so that for every pound of pressure we have 0.6 of a pound of pulling-power. An elevated-railway locomotive with 37,400 lbs. on drivers may, under the *most favorable conditions*, exert from one-third to one-fourth of this weight as tractive force, an average of 11,400 lbs., which our grip will produce with less than 78 lbs. per square inch, which may be multiplied several times without injury to cable or grip.

4. Next as to the question of economy.

In a cable system water and coaling stations are unnecessary; less water is needed, less oil and waste, and from one-half to one-third the quantity of coal, which may be of an inferior quality, costing perhaps one-half of what is now paid. Grades cease to be obstacles, and expensive constructions like that in New York at 110th Street and Eighth Avenue become unnecessary, and stations are made more accessible. It is clear that to stop five-car trains weighing 100 tons, with engine 23½ tons, together 123½ tons, requires more braking-force than the same train of cable cars with a 10-ton motor, a total of 110 tons; it is also evident that the lighter train will attain full speed more quickly. The horse power of a lo-

comotive is least at starting, just at the time when the greatest effort is needed, whereas with the cable train the motive power—the cable—is already in full speed, with the power of the enormous driving-engines ahead of it. It is a question in cable traction how to come into full speed slowly enough, and therefore to be entirely successful a cable road requires the most perfect differential grip.

No sand, to grind out rails and rolling stock, and annoy the public, is needed with the cable, and *it is the only known motive power which does not require a motor of great weight attached* to every train, the *power of which shrinks with slippery rails,* and *literally loses its grip and balks when most needed. Had the New York elevated railways been operated by cable during the great "blizzard" of March* 1888, *all traffic would not have been suspended.*

As to the amount of power expended in driving the plant, reference is again made to Mr. Leverich's paper on the New York and Brooklyn Bridge, wherein it is stated that the highest horse-power developed by the engines was 394.5, and that to drive the plant alone, cable included, required 47.7 horse-power,—which gives 87.99 per cent to be utilized for cars and passengers.

The following statement comparing the motive-power expenses of locomotives and cable service has been pre-

pared by Mr. Thomas C. Clarke, C.E., from actual data, and so clearly demonstrates the great economy of the cable that further argument is unnecessary.

NEW YORK March 29, 1889.

C. Tiers, Esq., President The Rapid Transit Cable Co.,

No. 12 Broadway, N. Y.

DEAR SIR: I have examined the drawings and working-models of your Company's new system of cable transit, as applied to elevated railways, and have the honor to report as follows:

The problem of Rapid Transit in cities demands for its solution elevated or tunnel railways, and special motors to draw the trains, suited to these structures.

All motors are of two kinds: those which carry their own power with them—such as locomotives, compressed-air motors, and electrical storage-battery motors; and those which derive their power from a fixed station. Such are electrical motors using a wire overhead, or in a tube; and cable motors gripping a moving cable driven by a fixed engine. All of these are different ways of utilizing the energy of coal.

All self-contained motors have one great merit—in case of breakdown their place can be taken at once by others, and the movement of trains be but little delayed.

They are all subject to one great disadvantage—their power is limited by the adhesion of their wheels to the rails, which itself depends on their weight. This weight is destructive to

the elevated railways on which they move, and even with the utmost practicable weight the gradients are limited to about 2 feet in 100, or 104 feet per mile. This makes it necessary to build high viaducts, like the Eighth Avenue Elevated at 116th Street, New York, and this means stations difficult of access.

Locomotives in cities are objectionable on account of their noise, smoke, and cinders. They exert their least power when starting so that time is lost in getting up speed of trains. Where stops are frequent, this peculiarity limits the average speed to not over 12 miles per hour, and to make this the locomotive has to run 18 to 20 miles an hour when at its highest speed.

Thus it appears that although the locomotive is the best thing we have at present, it has some serious defects.

When we come to the second class of motors which derive their power from a fixed station, we may say that the electric-wire contact motor has most of the defects of the locomotive without its advantages. Grounding of a wire will stop all the trains. It cannot climb steep grades, as its power depends, like the locomotive, on adhesion derived from weight. Magnetic adhesion is claimed for it, but admitted to be unreliable, and failing to appear when most wanted. So far as we know, it is much more costly than the locomotive for the duty of drawing heavy trains at high speed, burning about double as much coal to create the power.

The cable system has one great advantage—with a light motor it can climb gradients of about any degree of steepness. This means that the elevated railway may follow the contour

lines of the streets, and the stations never be over 18 or 20 feet above their level.

In the past it has had several serious defects. The grips and the cable wear out very fast, and when the cable breaks all trains stop. It has no power to work brakes. It has no power to move itself independently from a moving cable, and needs a locomotive to take it out of the way or to the shops if disabled. Its economy of working has been hampered by these drawbacks.

Your system of improved motors and cables seems to me to overcome all these defects.

Your rolling grip enables a much higher speed of cable to be used than heretofore possible, and that without wearing out itself or the cable. It can get up speed much quicker than locomotives can, and that without any disagreeable jerk. It lets go and picks up the cable anywhere, quickly and surely. The danger of stopping traffic has been overcome by using two cables, always having one ready to pick up in case of accident to the other. Your arrangements for curves, switches, and cross-overs seem to me to be practicable.

Your system of making the revolution of the wheels drive the pumps of an air-compressor, and store up the power in tanks on the motor, not only gives the necessary power to work the brakes, but makes the machine a self-contained motor, fit to take itself out of the way, and run alone.

All practical men look to economy of time in running and to economy of money in working; so I add a few facts that will be of interest.

The average of several trips on the Third Avenue Elevated, between South Ferry and 127th Street, timed by me, gives, with ordinary five-car trains,—seats filled, but few standing,—as follows:

Distance ..... $8\frac{40}{100}$ miles.
Total time..... 47 min. = 11 miles per hour nearly.
Deduct 26 stops @ 20 sec.... 8′ 40″

Running time between stations 38′ 20″ = $13\frac{1}{8}$ miles per hour.

In this case there were no delays, and the train ran rapidly; with heavy trains, slippery rails, etc., this time is reduced to 10 miles per hour.

When the trains are running at full speed they average from 18 to 23 miles per hour, varying according to weight of train, direction of grades, etc.

The time between 23 and 10 miles per hour is lost by getting up full speed and slowing down. More powerful brakes would save a little on the latter. The former cannot be saved with locomotives, but can by cables.

My observations divide the time as follows:

What Doing.	Time.	Distance.	Rate, feet per second.	Rate, miles per hour.
Acquiring full speed.....	30 sec.	300 feet.	10	
Full speed.....	40 "	1260 "	32	$22\frac{1}{8}$
Slowing down.....	20 "	200 "	10	
Total between stations $\frac{1}{4}$ mile apart.....	90 sec.	1760 feet.	$19\frac{1}{8}$	$13\frac{1}{8}$

Equal time could be made by a cable running 16 miles per hour, as follows:

What Doing.	Time.	Distance.	Rate, feet per second.	Rate, miles per hour.
Getting up speed.....	5 sec.	50 feet.	10	
Full speed.....	65 "	1510 "	23	16
Slowing down.....	20 "	200 "	10	
Total.....	90 sec.	1760 feet.	19⅓	13⅓

Or, if the cable was run at 20 miles an hour, which is entirely practicable with your system, we shall have the following result:

What Doing.	Time.	Distance.	Rate, feet per second.	Rate, miles per hour.
Getting up speed.....	5 sec.	50 feet.	10	
Full speed.....	52 "	1510 "	29	20
Slowing down.....	20 "	200 "	10	
Total.....	77 sec.	1760 feet.	22	16

The average time would be increased to 16 miles per hour and the time between stations reduced from 90 to 77 seconds—a saving on the Third Avenue line of 5 min. 38 sec.

Should it be possible to run cable 25 miles an hour, the saving would be nearly 11 minutes.

If the experience of the operations of the Brooklyn Bridge during past five years is worth anything, the economy of cable over locomotive power is very great. (See table, page 24.)

It appears that the cost on Manhattan lines per mile run of train was..... ... $61\frac{89}{100}$ cents.
Per passenger carried, the cost was... ..... 2.79 "
While on Brooklyn Bridge it was, per mile run of trains..... $45\frac{84}{100}$ "
Per passenger carried..... 1.52 "

This difference is chiefly due to the cables, which cost 8 cents per mile run; or. if no locomotives had been used for switching, 3.26 cents per mile run, against cost per mile run of trains of Manhattan locomotives of $25\frac{1}{10}$ cents.

It is fair to say, that the trains are better balanced on the Brooklyn Bridge than they would be on the Manhattan lines but the saving would in any case amount to at least twelve cents per mile run of trains, and on the whole mileage, in round numbers, eight hundred and sixty-five thousand dollars annually.

(Signed) THOS. C. CLARKE, *Consulting Engineer*,
1 Broadway, New York.

Comparison of the Cost of Operating Manhattan Railway and New York and Brooklyn Bridge.

MANHATTAN RAILWAY.

For year ending September 30, 1887. (Report to R. R. Commissioners, State of New York.) Passengers carried, 158,783,241. Miles run by trains, 7,202,966.

Designation.	Items.	Total.	Cost per each Passenger carried.	Cost per each Train-mile run.
Repairs of locomotives.....	$196,044			
" of machinery, tools.....	7,370			
Maintenance equipment.....	74,166			
Wages, engineers and firemen ...	693,013			
Fuel for locomotives.....	731,401			
Oil and waste, average.	88,241			
Water supply.....	65,063		cts.	cts.
Expense of motive power.....		$1,855,298	1.169	25.20.
Repairs of cars	249,733			
Wages, conductors, guards.....	546,830			
Train supplies and expenses.....	26,618			
Expense of cars		823 181	.512	11.43
Maintenance of way and structures		412,242	.246	5.72
Station agents and gatemen.....	431,110			
Porters at stations..... ...	51,432			
Station supplies.....	68,973			
Station expenses.....		551,515	.348	7.65
Yard-, flag-, and switch-men....	147,857			
Other expenses for conductors...	303,677			
		451,534	.271	6.26
General expenses.....		414,697	.247	5.73
Total.....		$4,508,467	2.793	61.89

NEW YORK AND BROOKLYN BRIDGE.

For year ending May 31, 1887.

Passengers carried, 26,388,808. Train miles run, 877,496.

Designation.	Items.	Total.	Cost per each Passenger carried.	Cost per each Train-mile run.
Fuel and water	$10,668		cts.	cts.
Repairs	9,152			
Wages, engineers and firemen	21,977			
Cost of Locomotives: 89,200 miles run at 46 cts		$41,797		4.74
Coal and water	12,244			
Repairs	4,273			
Wages, engineers and firemen	12,117			
		28,634		3.26
Cost of motive power		70,431	.267	8.00
Repairs, cars	40,065			
Other expenses, R. R.	13,595			
Grip	13.044			
Wages, conductors and brakemen	63.411			
Expense of cars		130,115	.493	14.80
Maintenance of way; structure; damages to persons		19,655	.073	2.24
Tollmen	20,444			
Gatemen	10.319			
Police	38,197			
Station expenses		68,960	.261	7.86
Switch-, yard-, and flag-men	21,004			
Miscellaneous expenses	30,703	51,707	.200	5.88
General expense		62.026	.235	7.06
		$402,894	1.523	45.84

	cts.	cts.
Total cost of operating Manhattan Railway	2.793	61.89
Total cost of operating Brooklyn Bridge	1.523	45.84
Excess	1.270	16.05

THOS. C. CLARKE, *Consulting Engineer*,
1 Broadway, New York.

Finally, the advantages of a cable system for operating elevated railways may be summarized as follows:

1. Less cost of new, or extension of old, lines.
2. Certainty of operation, unaffected by weather.
3. Non-dependence on adhesion.
4. Low cost of operation, this becoming more pronounced as the traffic increases.
5. Less cost of maintenance of motive power, track, and structures.
6. Less cost of fuel, water, oil, waste, and other supplies.
7. Less liability to suits for damages.
8. Less repair-shop room and engine-yards.
9. The destruction of the great obstacle to running-time, i.e. grades and the lowering of structure to an easily accessible height.
10. Increased running-time with the same maximum speed.
11. Increased capacity.
12. Increased dividends.

STREET SURFACE RAILWAYS.

WHAT has been said regarding elevated railways will apply largely to surface or underground roads where the traffic is heavy. It may be taken as a rule, that the greater the traffic the greater will be the economy of cable traction for any street, elevated, or underground railway.

Where surface cable roads have been properly constructed they have proved signally successful, the chief merits being greater economy and certainty of operation than any other system; its great expansibility, providing instantly for any possible fluctuations of traffic without appreciable expense other than the necessary extra cars: greasy rails and steep grades have no effect, and both track and cars may be lightly built, as adhesion is not a factor.

The principal objection raised against the system is its great first cost; but when the result attained is considered, and the fact realized that on seven roads in the city of New York enough money is annually expended in renewals of horses, shoeing, repairs of harness and stable equipments alone, to pay the interest at from 5 to 6 per

cent on the cost of construction, it appears, not that the first cost of cable, but the annual waste, and ruin of horses, is excessive. In the one case we have a certainty of operation under all conditions of climate, not afforded by any other system. The plant requires but slight repairs when the Rapid Transit Cable Company's improved differential grips and other improvements are used; the grips at the same time entirely obviating the disagreeable lurch sometimes noticed in starting cable cars, and graduating the speed perfectly, with the least wear to grip or cable. In the other, thousands of dollars absolutely thrown away and horses ruined by the score.

It is estimated by high authorities that with a traffic of 4000 passengers per mile per day, a cable road can be operated as economically as by horses, beyond which point the economy of the cable increases rapidly. Of the six cable lines first constructed in San Francisco the mayor of that city states: "These roads pay dividends from 8 to 24 per cent per annum."

Another objection is that in case of any accident happening to the machinery or cable, traffic is at once suspended over the entire line. To this we reply that all machinery, i.e. the engines in the power houses, should be duplicated, which is a necessity in *any* mechanical system of transportation, whether cable or electricity, as

even the best engine is liable at some time or other to break down. The arrangement should be such that the idle engine can instantly be thrown into gear with the driving-drums. As for the cable, there is no reason, with proper precautions and examinations, why it should ever cause any interruption to traffic by breaking. No cable ever yet gave way suddenyl; there are always premonitory symptoms of failure.

The solid jaw-grips are without doubt destructive alike to the cable and themselves, as is instanced by their "shoes" or "dies" wearing out, in some cases in only ten days, while the average life of cables is about twelve months. This objectionable feature is largely overcome by the Rapid Transit Cable Company's improved grip, which combines all the advantages of great power and long contact possessed by the solid grip, as well as the advantages of least wear possessed by the roller grip, thereby extending the life of both and materially reducing expenses of maintenance. This has never before been successfully accomplished, and the Rapid Transit Cable Company has thus overcome another objection.

All these improvements go to make up the most perfect and complete system of cable transportation ever invented, and they are the result of much thought, labor, and experimenting, by experienced men who have realized the imperfections in existing cable systems.

UNDERGROUND RAILWAYS.

ALTHOUGH there are at present no underground railways in operation in the United States, they are among the possibilities in the not distant future, and the demands of traffic on them when constructed will, in all likelihood, be at least as great as on the present elevated roads.

The best service will be given by moderate-sized trains, at short intervals, with the ability to get under way, and to stop, quickly; they must follow the grades of the street and keep as close to the surface as is possible to make the stations easily accessible. Heavy locomotives *should not* be used, and the rolling stock should be as light as is consistent with strength and safety, because of the jar produced by rapidly moving trains affecting the foundations of adjacent buildings, which under certain conditions might endanger their stability; besides, the impure gases, steam, grease, and cinders, inherent to the locomotive, vitiate the air in the tunnels.

In this character of railway, as in the others, the

present objections can be overcome by the employment of the Rapid Transit Cable Company's system of *motive power*, which is the only cable traction system practicable for operating railways of heavy rolling stock or at high speed.

The Rapid Transit Cable Company's

COMBINED ANTI-FRICTION BELT-GRIP AND MOTOR.

(PATENTED.)

In Plate I. it is seen perspectively, as in Plate II., the same with the cab removed.

Plate III. represents a longitudinal section on a broken plane, the combined anti-friction lower grip-shoe and pick-up, and belt having an outer leather surface, in contact with the cable, being indicated by dotted lines. Full lines show the inclined guide-wheels, the small wheels at the ends for imparting motion to the belt prior to its contact with the cable, and the capstan-wheel for applying the grip.

Plate IV. is another view, showing the air-reservoirs and combined pump- and engine-cylinder (most ingeniously and simply arranged, and without slide-valves or valve-gear) attached to the bearing-wheels for the purposes hereinafter described.

Plate V. shows a general arrangement of the train-brakes and couplings.

In Plate VI., Fig. 1 is a sectional cut showing the relative positions, on a curve, of the guard-wheels to the guard-rail, and the grip guide-wheels to the curve-pulleys, of which Fig. 2 is a side elevation. Fig. 3 shows a girder for supporting the track over the space occupied by the curve-pulley, and Fig. 4 is an elevation of the superstructure.

Plate VII. shows a curve in the track and a junction of two cable sections, both in plan.

The action of the grip is as follows: When directly over the moving cable, a pall holding the large capstan-wheel is tripped by a treadle, and as the lower shoe falls it is forced to one side of the cable by a rod and toggle (not shown). When the lowest point is reached, the shoe swings under the cable; then the capstan-wheel is turned, winding up a chain which draws the lower shoe upwards, lifts the cable, and brings it first into contact with the small wheels. These instantly begin to revolve, imparting motion to the grip-belt, which is thus caused to travel at the cable speed before pressure, by further turning of the capstan-wheel, is applied. The grip-belt passes under a long solid brake-shoe, against which the inner metallic braking surfaces of the belt bear, producing the necessary tractive power.

The lower grip-shoe and pick-up is made of the most highly-tempered steel or aluminium metal, through which there is a constant automatic circulation of water or other fluid to keep it cool. This reduces the friction and wear to the minimum, as has been thoroughly demonstrated by careful experiments.

As the speed of cable and motor is thus differentiated in the travelling grip-belt, the train inertia is gradually overcome, and the speed of the train perfectly graduated.

The next feature of note is, that this machine is a complete self-contained motor.

On each side there is fixed a pump worked as shown, by the revolutions of the bearing-wheels. When the lever, indicated by dotted lines in Plate IV., and which governs the throttle-valve of the combined pump- and engine-cylinders, is placed upright, they act as pumps, and force sufficient air into the reservoir to actuate the brakes throughout the entire train, and to propel the motor when detached from the cable backward or forward by moving the same lever in the corresponding direction, with a speed regulated by the valve-openings—the pumps being thus converted into engines.

In brief, the following advantages are claimed for this machine over any heretofore produced:

1. Great power and ability to haul heavy trains at high cable speed, without injurious pressure or wear to cable or grip,—com-

bining all the advantages possessed by both roller and "jaw" grips (which are explained in the back of this book), without their defects.

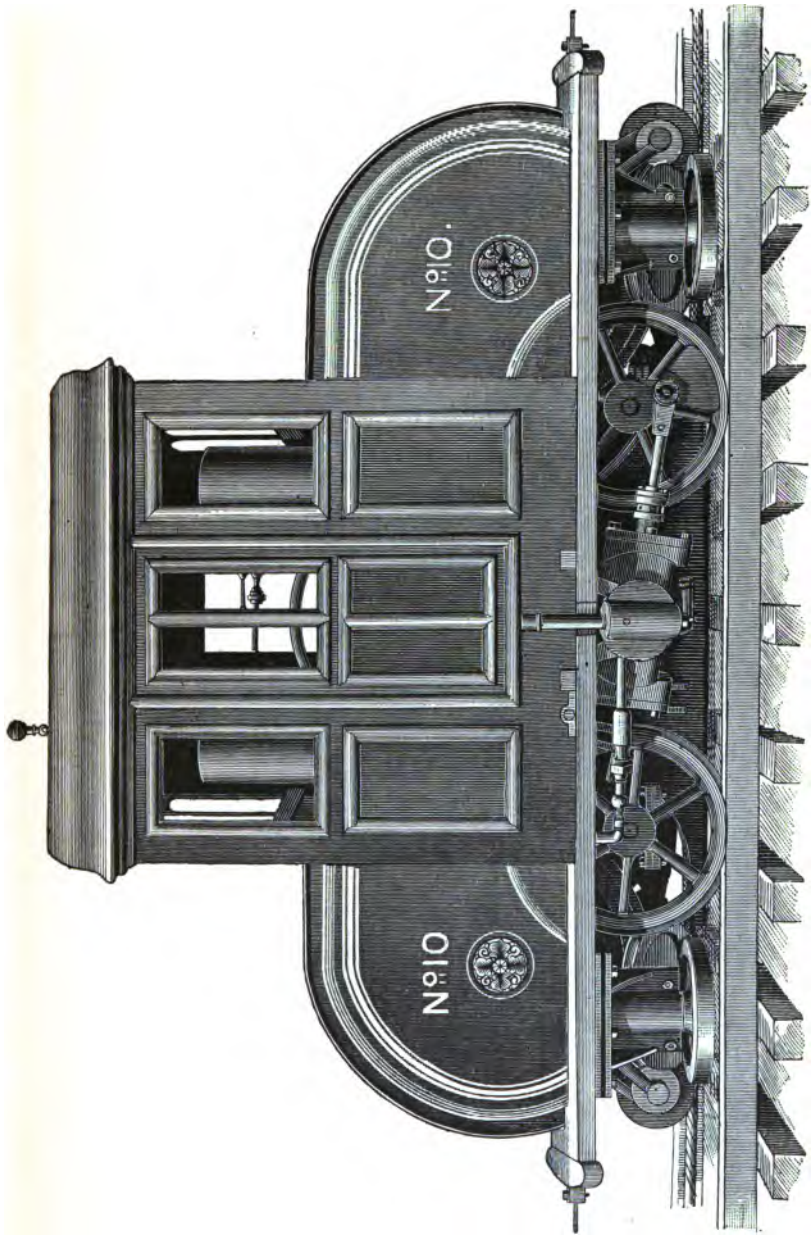
2. It is a self-contained motor, and provided with means for operating any variety of air-brakes, without changing the car-fittings, thus giving the operator absolute control of the train,—a necessary element of safety universally recognized by railway men.

3. It traverses curves easily, and always lays the cable in its proper place against the side-pulleys.

4. No change in cars is required, and foreign cars can be run on the road as with a locomotive system.

5. Simplicity of construction and certainty of operation.

PLATE I.



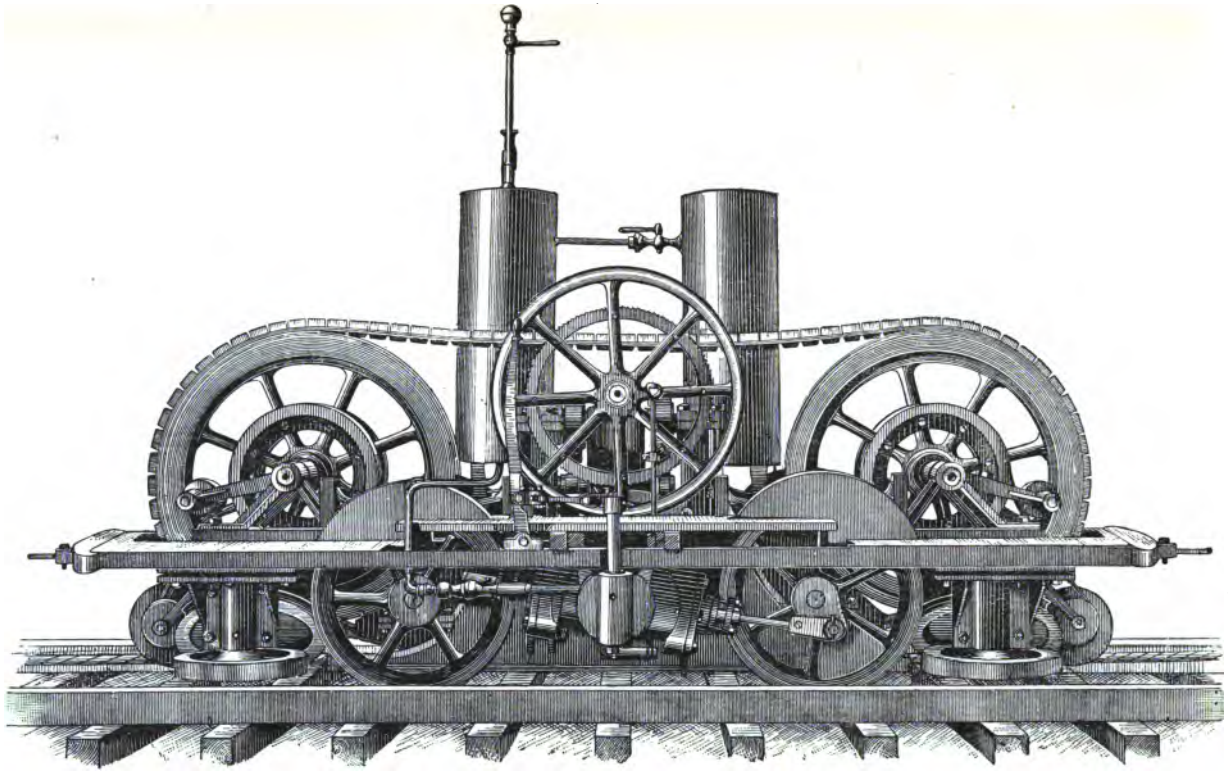


Fig. 1

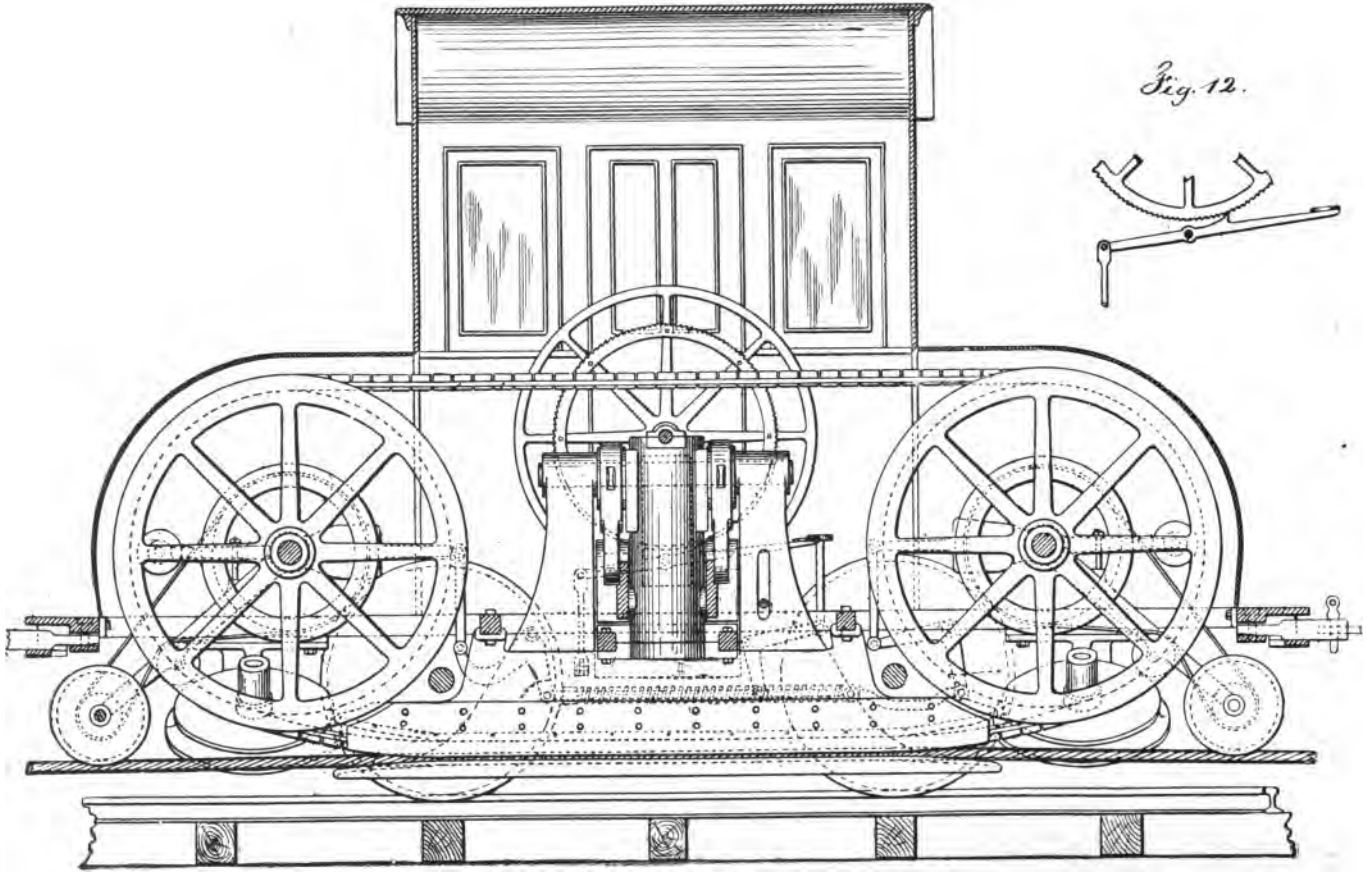


Fig. 12.

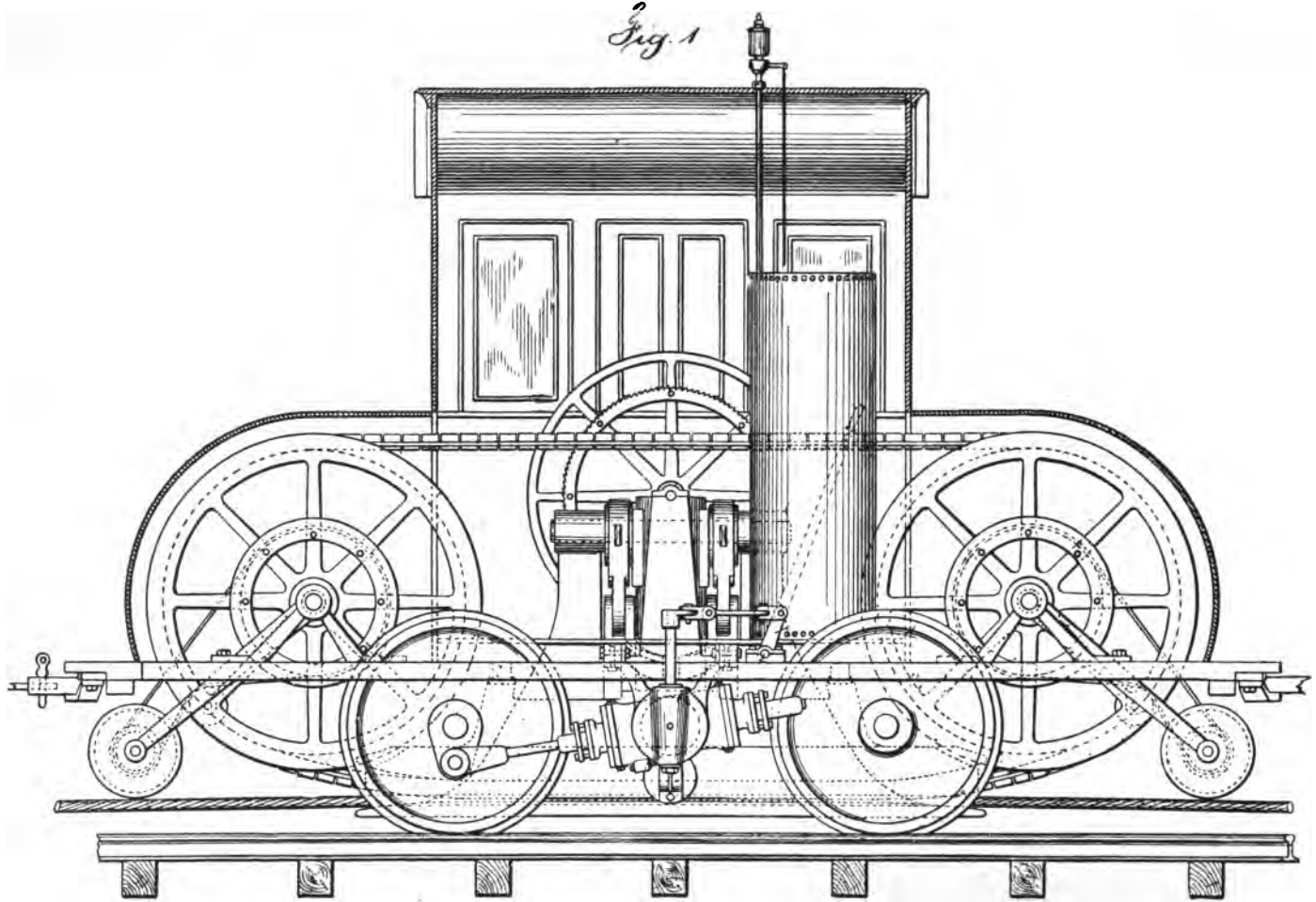


Fig. 1

Fig 11.

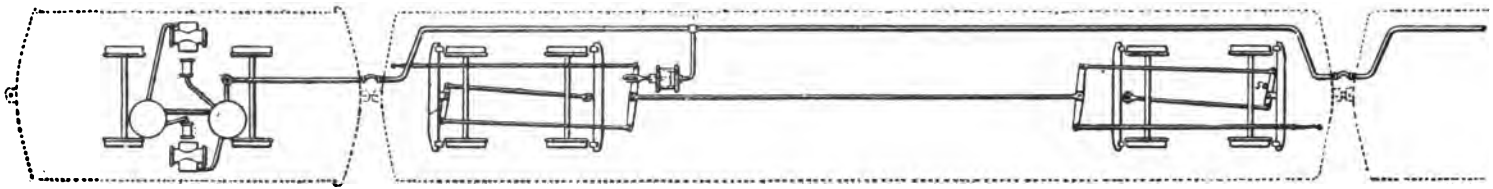


Fig. 14.

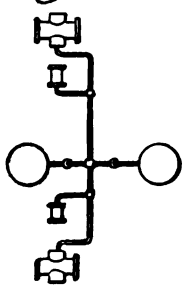
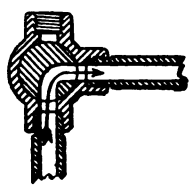


Fig. 12.



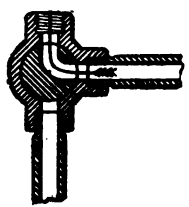


Fig. 13

Fig. 1

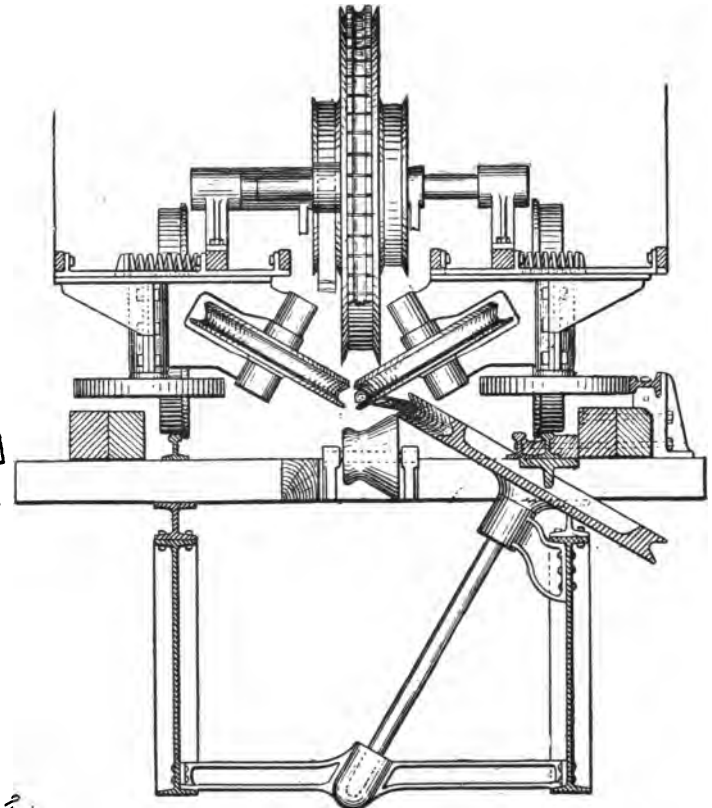


Fig. 3.

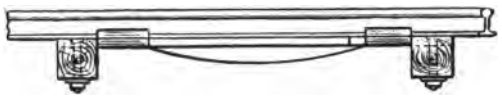


Fig. 2

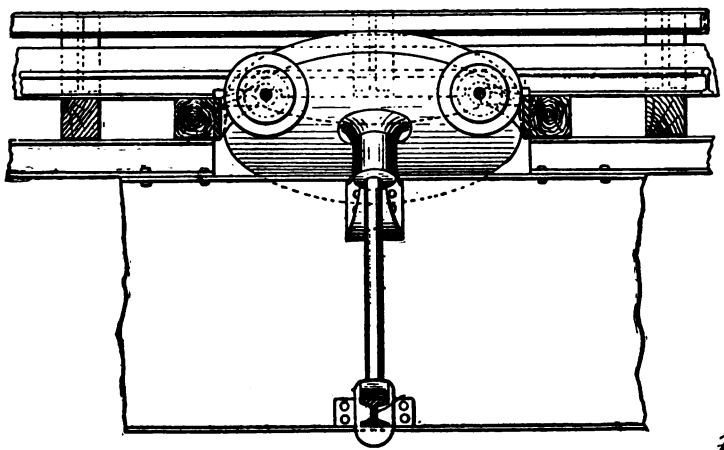


Fig. 4.

Fig. 6.

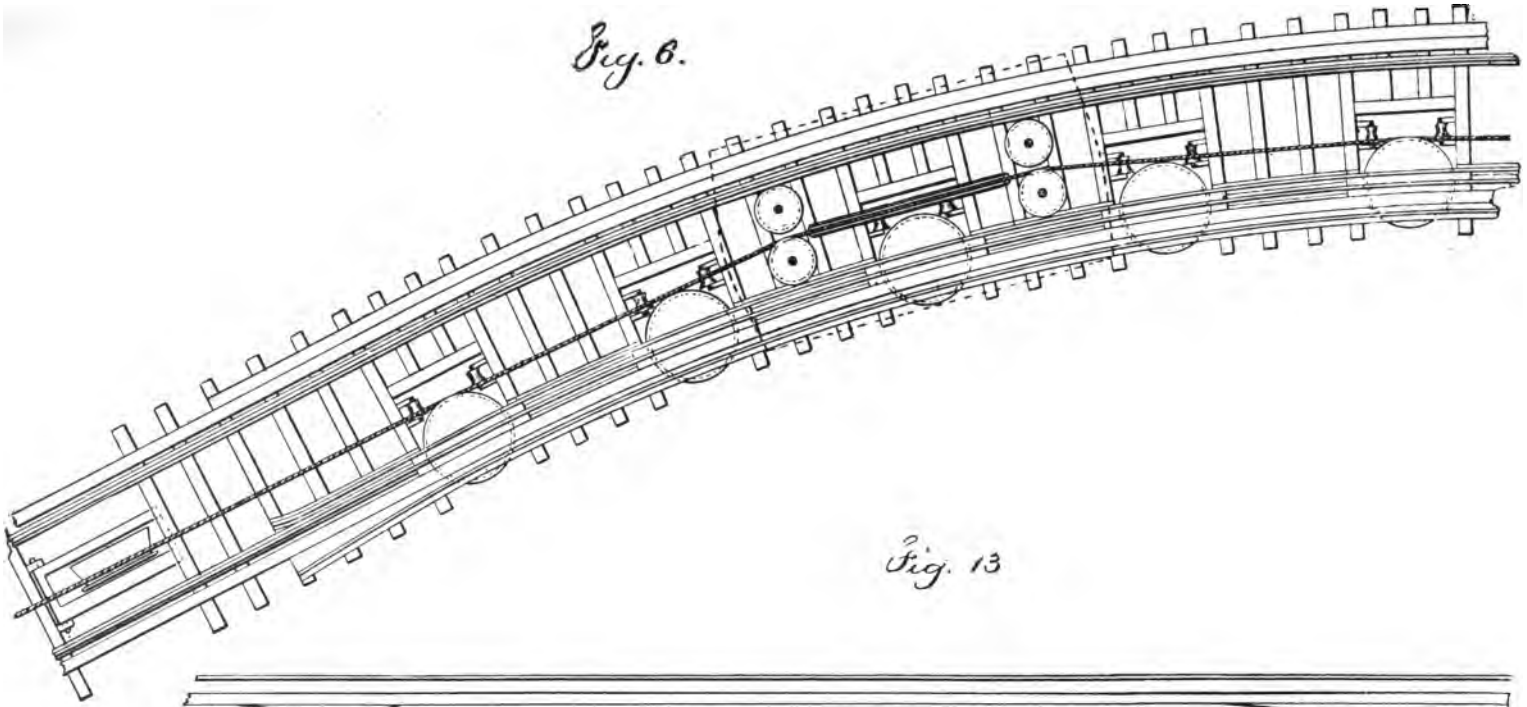
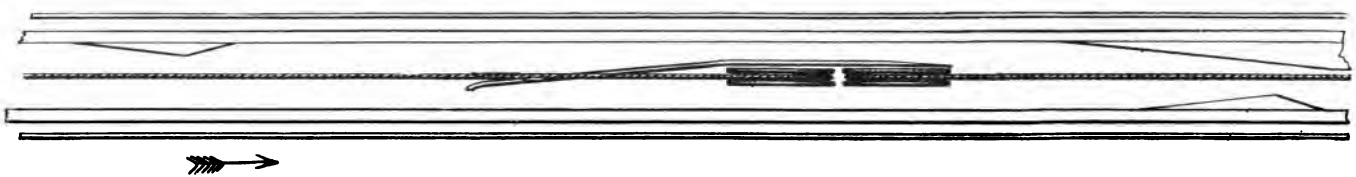


Fig. 13



The Rapid Transit Cable Company's

COMBINED ANTI-FRICTION CLIP-BELT SHIFTING GRIP AND MOTOR,

WITH DUPLICATE CABLE SYSTEM.

(PATENTED.)

In Plate VIII. it is seen perspectively, coupled to a train, and in Plate IX. it is represented with the cab removed.

Plate X. is a partial longitudinal section on a broken plane in which is shown the revolving belt of clips with inner surfaces of leather, between which the travelling cable is held, and the large capstan-wheel for applying and releasing the gripping-jaws through which the belted clips run (as shown in dotted lines), and are forced with greater or less pressure against the cable, thus retarding the belt proportionately from the consequent friction of the outer metallic plates of the clips in contact with the metallic guide and gripping-jaws. This produces a greater or less differential speed of the revolving belt and travelling cable to the speed of the motor, and thus enables a gradual start or variable train-speed without injury to the grip or cable. To the left of the capstan-wheel is a vertical shaft having on top a crank with handle or a wheel, and terminating below in a bevel-gear wheel which engages with another keyed to the long shaft, by means of which the pick-up is operated, as well as the carrying sheaves at the end of the motor, which serve to properly guide the cable in its relationship to the revolving belt, and cause it to revolve at the same speed as the travelling cable, before their

contact. These are all very simply and positively accomplished by the continuous turning of the one crank, which, being a uniform motion, precludes any confusion of the operator.

Plate XI. shows the pick-up and supporting wheels in detail, and their transposition when operated. We will here remark, that though the pick-up is capable of being worked at any time, its use is seldom required, as the cable travels through the supporting wheels almost continuously,—during stops at stations and when varying the speed,—and is seldom dropped but at crossings, ends of sections, and the termini. In dotted lines below the capstan wheel is the automatic tripping device to release the cable at the end of a section or at any fixed point.

Plate XII. is a cross-section showing the shape of the clip-belt in its position between the gripping- and braking-jaws, which get their force from the connected compound levers and toggle, actuated by the large capstan-wheel. This grip is seen holding the right-hand cable, but may be easily shifted on its movable supporting frame, pneumatically with cylinders, as shown in plan view on Plate XIII. (or with a capstan bar), by the engineer or grip-man, to the centre (as required with a single cable), or to accommodate the left-hand cable (as in this duplicate system), which cable is seen supported by the end guide-wheels (previously referred to in connection with Plates X. and XI.) in Plate XIV. in their relationship with the guard-wheels to the guard-rail and curve-carrying sheaves, Plates XV. and XVI. respectively showing the same duplicate cables in plan of track on curve and its approach. This motor is also provided with combined air-pumps and engine-cylinders, and reservoirs, for the purposes previously explained in connection with the Combined Anti-Friction Belt Grip and Motor; therefore no further reference is necessary. But we will simply state the manner of operating the grip and motor:

Being adapted to a duplicate cable system that provides against the delays which might possibly occur in the use of a single cable the grip is shifted to a position directly over the cable it is desired to take (see Plate XIII.), two methods being provided in case of accident to one or the other. The horizontal crank or wheel actuating the vertical

shaft (see Plate X.) is then revolved continuously in the same direction; this causes the pick-up at each end of the motor (see Plates X. and XI.) to descend, pass under the cable, lift it, and throw in the carrying-wheels (see Plates X. and XI.) to support the cable in an elevated position, to be gripped by the clip-belt after the same has been put into motion by contact of the same supporting-wheels with the travelling cable, following which the pick-up is lowered slightly and withdrawn to one side of the cable. The train can now be started and speeded with a graduation exactly as the operator may intend by the turning of the large capstan-wheel that governs the powerful mechanical combination (see Plate XI.), which actuates the braking- and gripping-jaws,—increasing or lessening the required tractive power, and correspondingly regulating the speed of the train without any undue exertion of the operator.

If for any reason it should be necessary to communicate with or signal to the power-house, or stop one cable and start the other, it may be done direct from the trains or motors at any point on the line of railway, by our patent electric device; and in the event of thus transferring the power from one to the other of the duplicate cables, the grips are shifted conformably (see Plate XIII.).

In brief, the advantages of this duplicate system and combined grip and motor are as follows:

1. It is simple and certain in operation.

2. Only leather as a gripping surface is brought into contact with the moving cable.

3. It grasps nearly the entire circumference of the cable, and so requires very slight pressure to produce a required tractive force.

4. It will haul a much heavier train than can be done by any elevated railway locomotive.

5. It differentiates the speed perfectly.

6. It is practically adapted to high speed and heavy trains, and besides, being a self-contained motor, operates the train-brakes

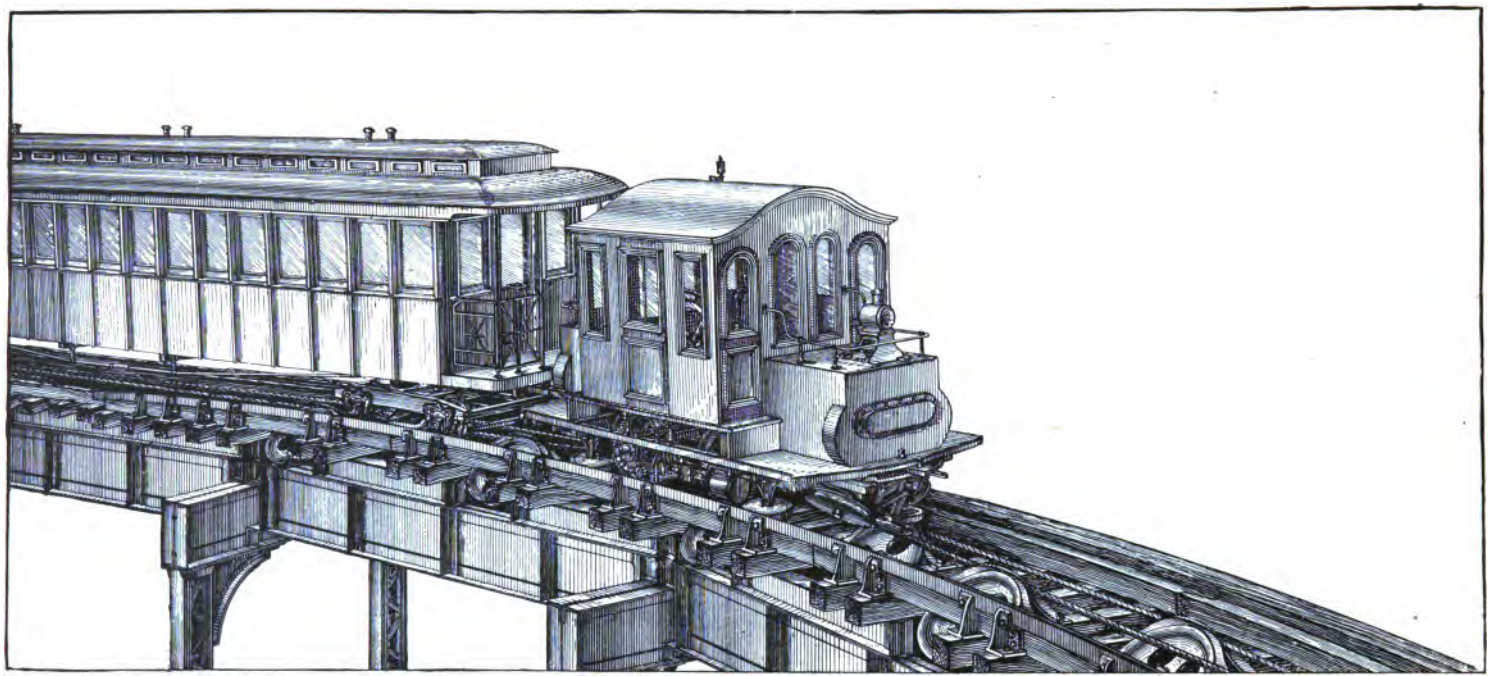
7. No alteration of cars is required.

8. There is no possibility of long delay by accident to cable.

9. Single lines with passing points may be operated when traffic

is not sufficient to warrant a double line, although the advantages of an elevated railway may be demanded.

10. Curves and loops of radii practical with cars generally employed can be easily operated, and with our improved devices it is possible to do so on those specially adapted to circumscribed localities.



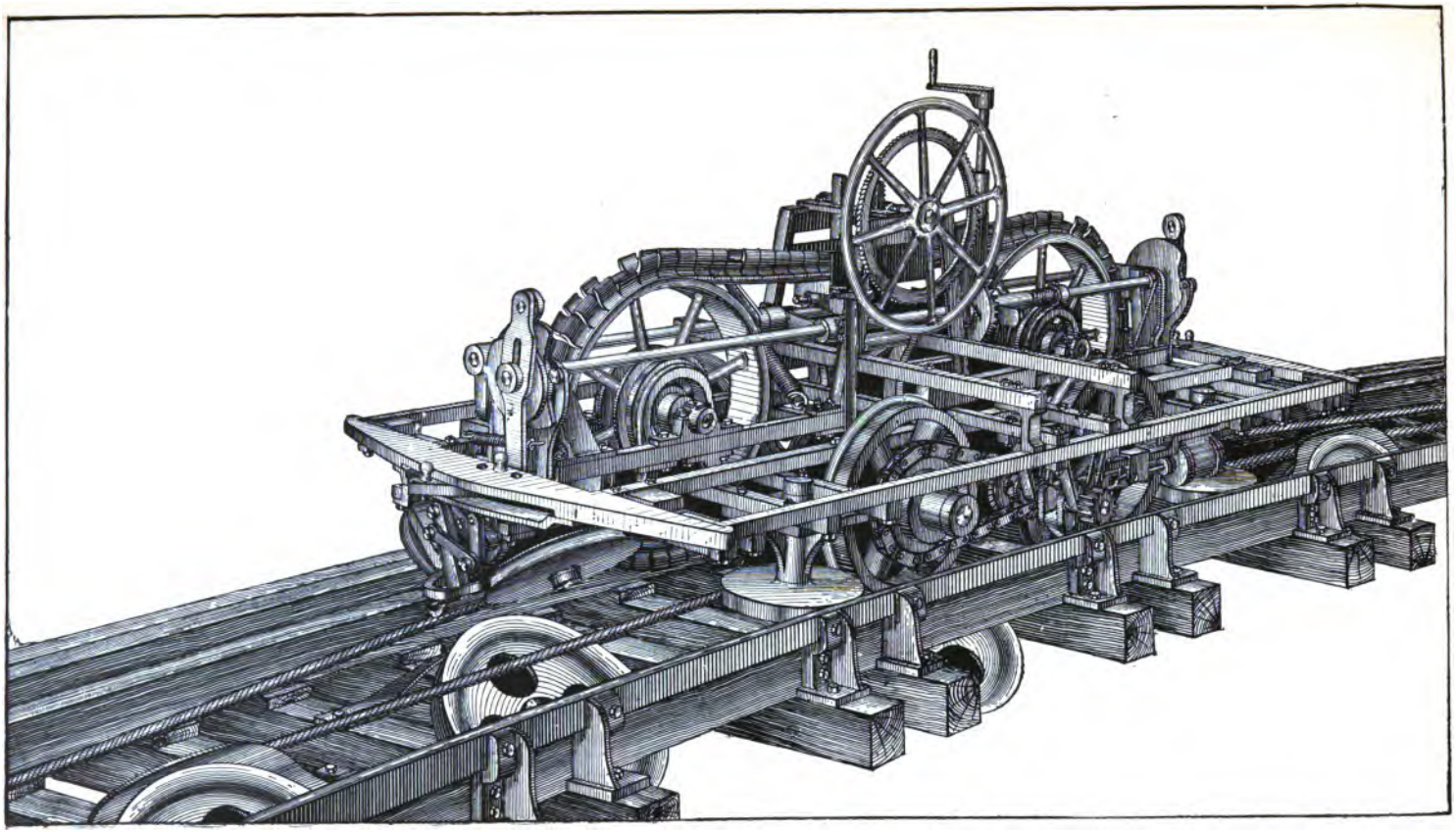


PLATE X.

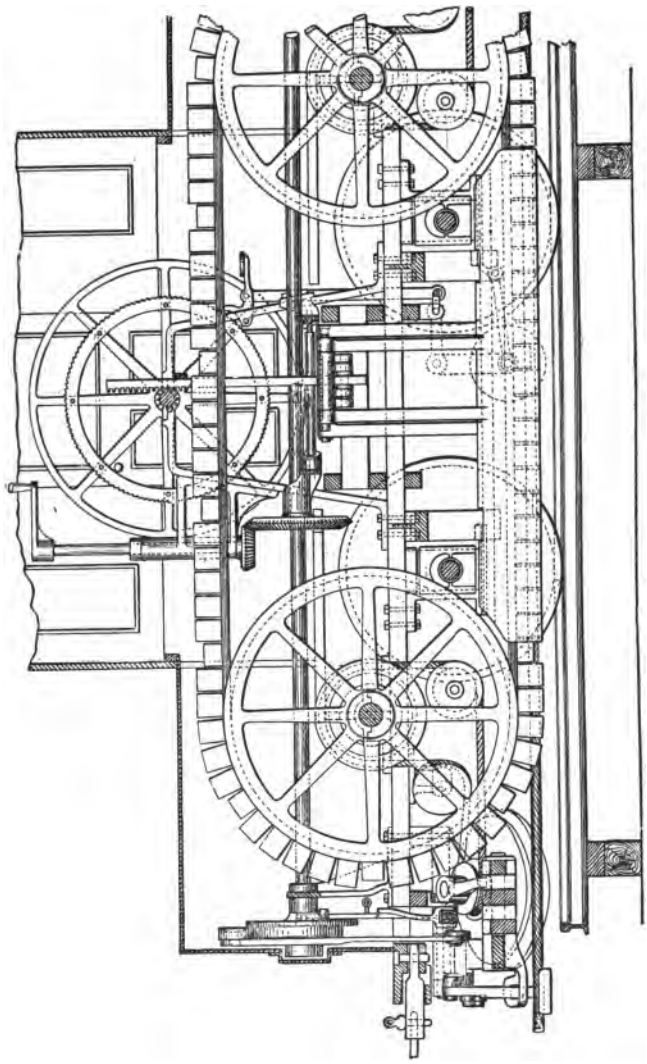


PLATE XI.

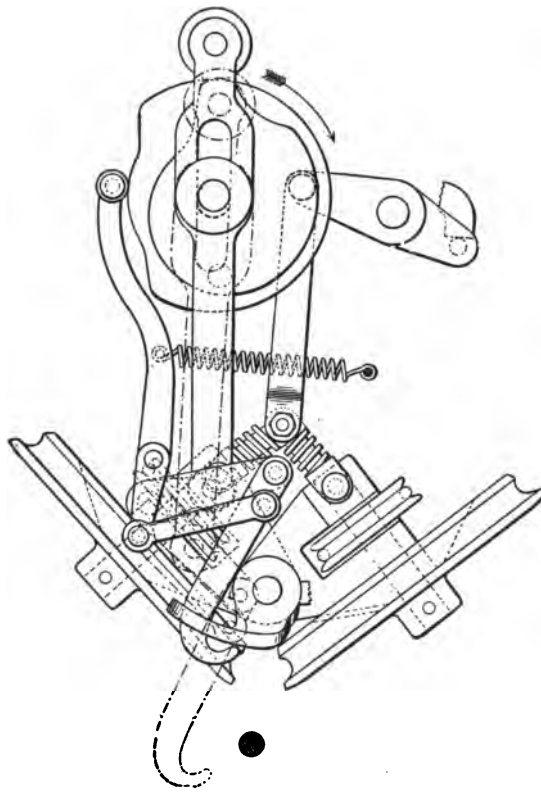


PLATE XII.

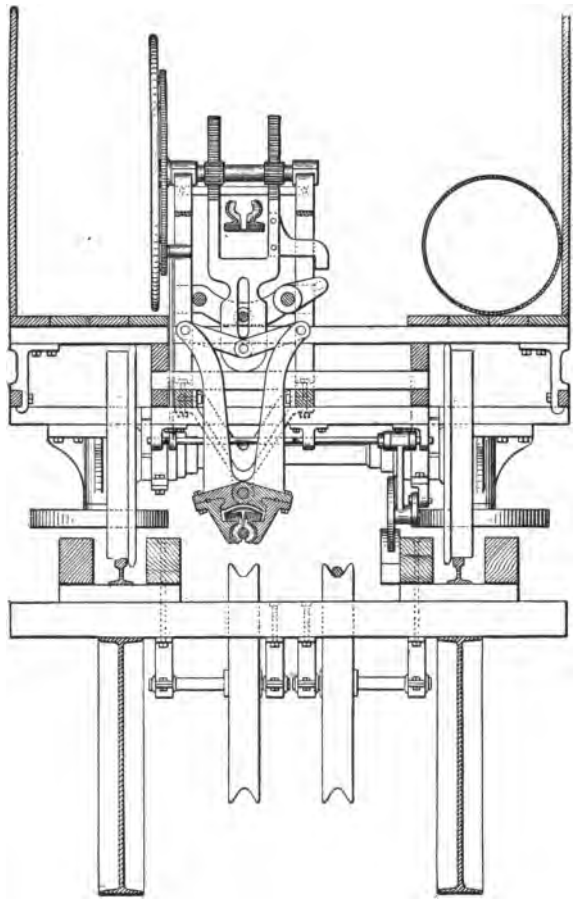


PLATE XIII.

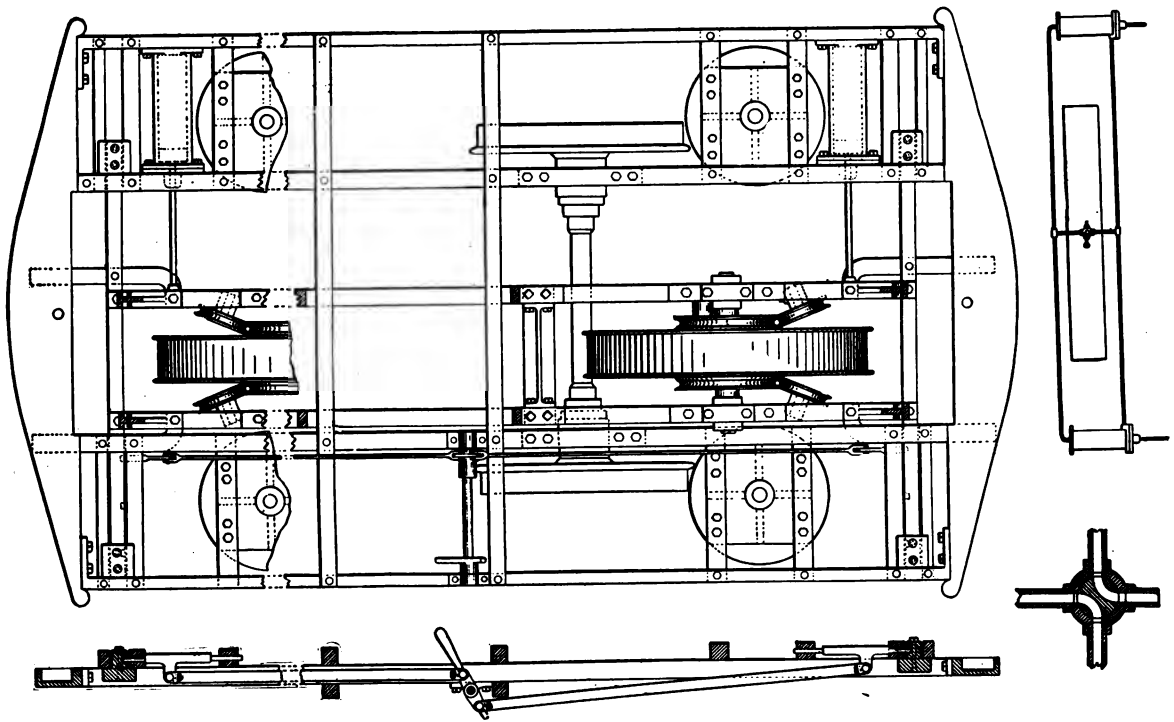


PLATE XIV.

Fig.

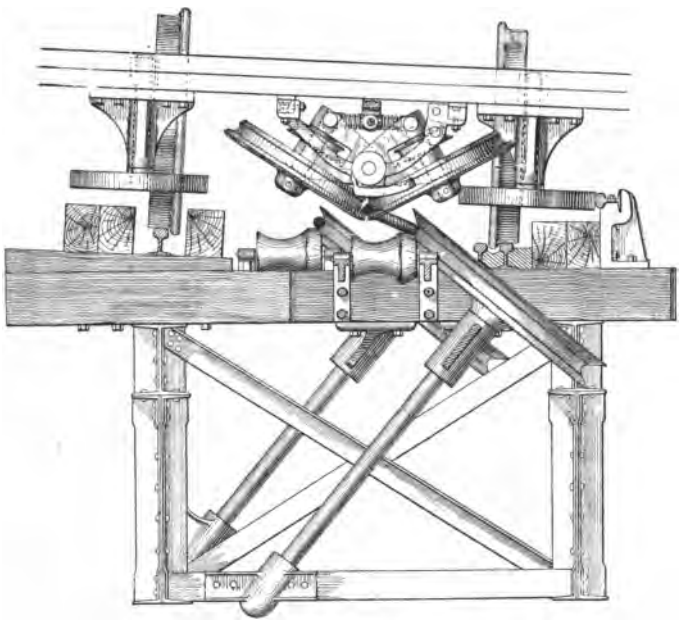


PLATE XV.

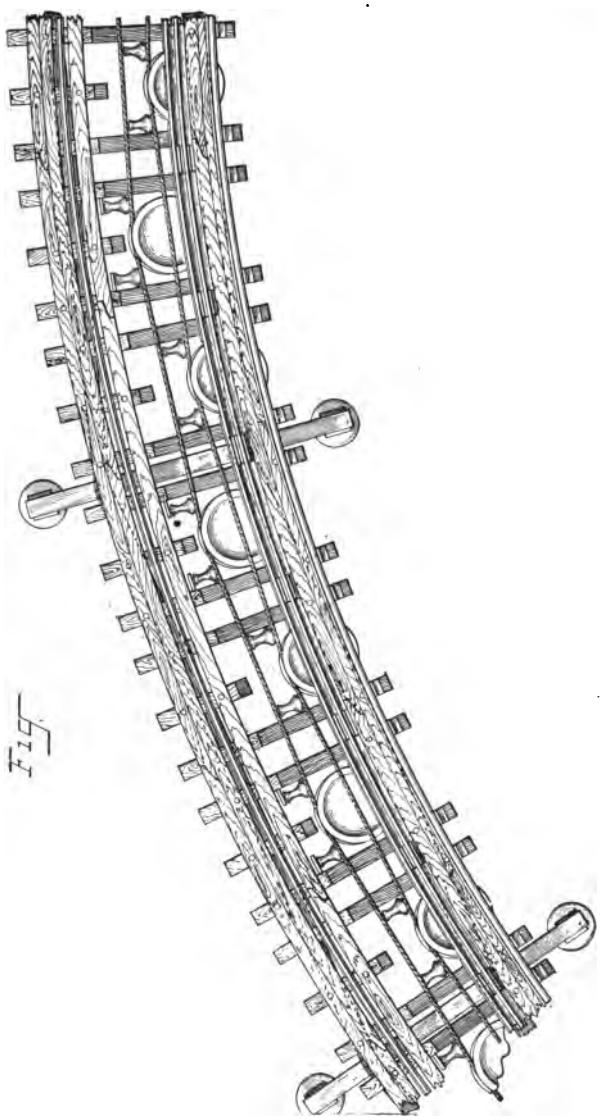


PLATE XVI.

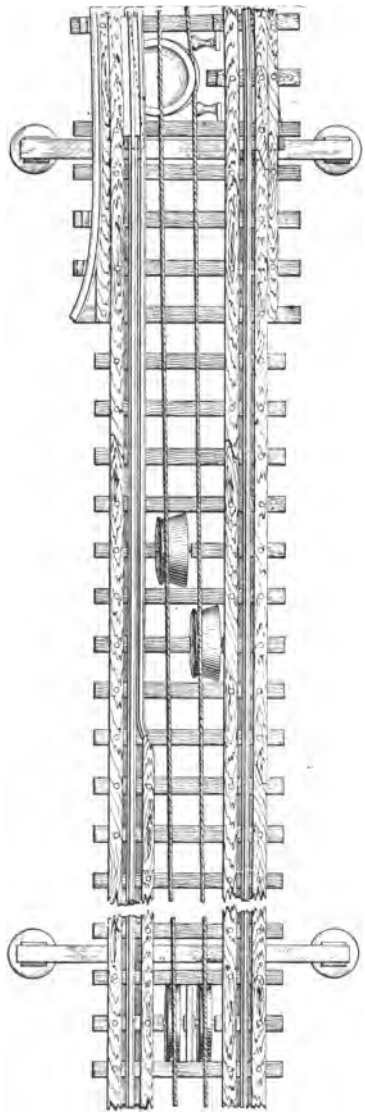


FIG.

DIAGRAM I.

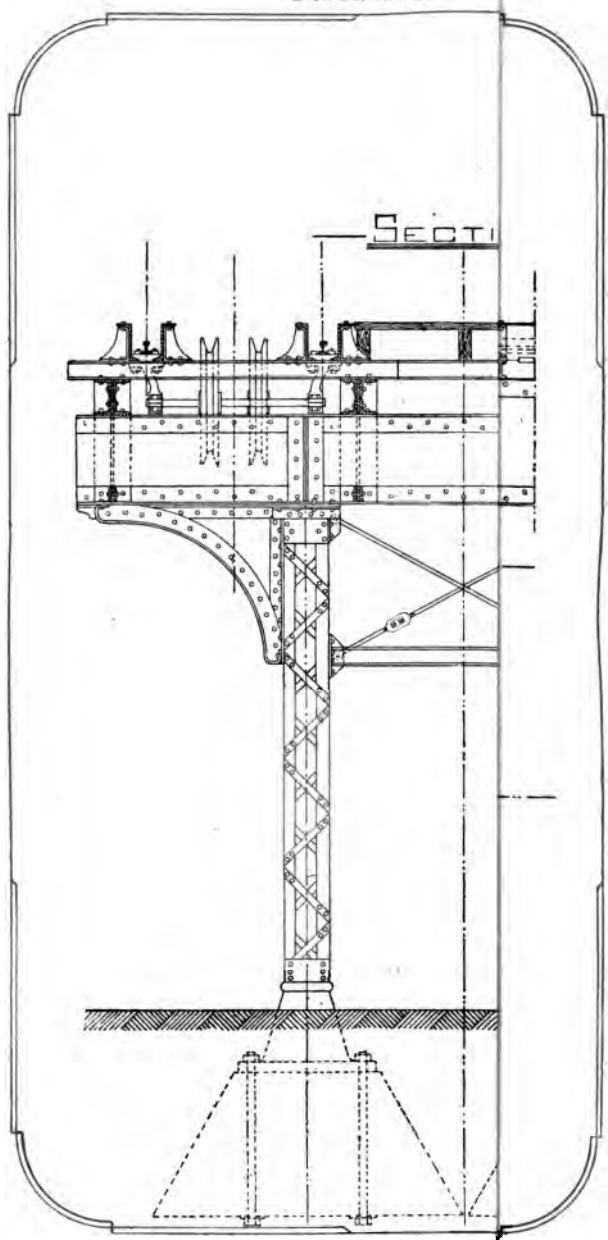
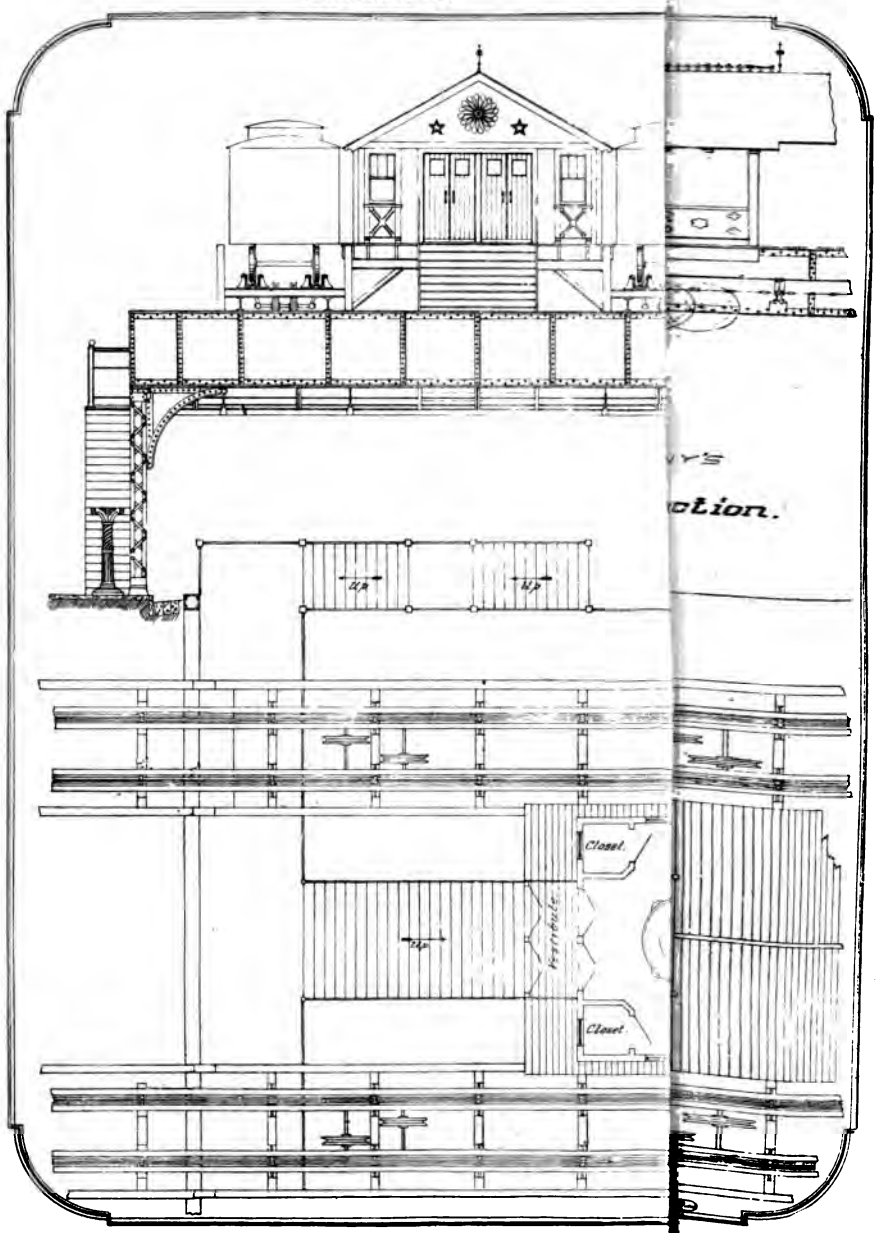


DIAGRAM II.



The Rapid Transit Cable Company's

SURFACE STREET-CAR CABLE TRACTION SYSTEM.

(PATENTED.)

In Plate XVII. is shown a side elevation of a street-car and trench, a part of the latter broken away to expose the grip and cable.

Plate XVIII. shows a cross-section of the car gripped to the cable.

Plate XIX. is a cross-section of the man-hole and drainage system in connection with the trenches of a double-track railway.

The Grip is the most important feature of this system, as it involves the principles and has the advantages of those (combined with the motors) previously explained, which give great efficiency, and enable a perfect graduation in the start of a car and variation in its speed, without injury to the cable and with the minimum wear: this because it has all the advantages of the roller grip and the long contact and bearing-surface of the jaw-grip,—thus a grip conbining the advantages of both without their defects. The brakes are released and the grip applied, or *vice versâ*, by a very simple and positive mechanism, which can be operated from either end of the car by turning a crank or wheel in a continuous direction, thus guarding against any confusion to the grip-man. The grip-man can throw out or pick up the cable at any point on the road, and instantly detach the grip from the car, if desired.

The trench has been designed with a view to durability, and simplicity and economy in construction; with easy accommodation for

the working parts, convenience in its maintenance and inspection, and thoroughness in drainage.

By employing our special grip with the water-circulating, anti-friction supporting shoe, it is practicable to construct a shallower trench then is generally used, and thereby effect a considerable saving in the construction account.

The electrical signalling device (previously referred to) employed in conjunction with the other systems has its application to this system also, and places a means within the hands of the grip-man of each and every car to instantly signal to the power-house, or stop the travel of the cable, in case of necessity.

Fig

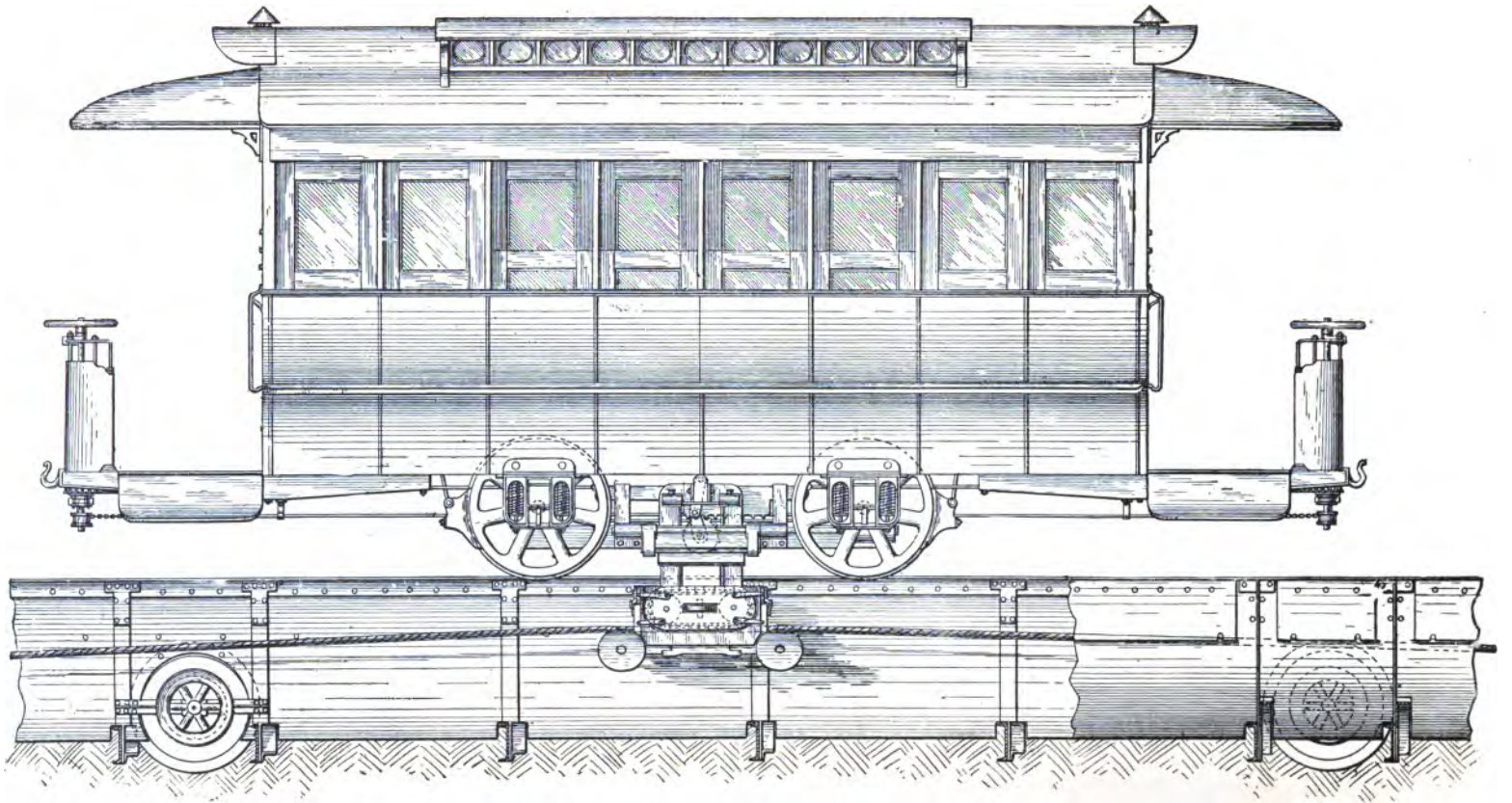


PLATE XVIII.

Fig

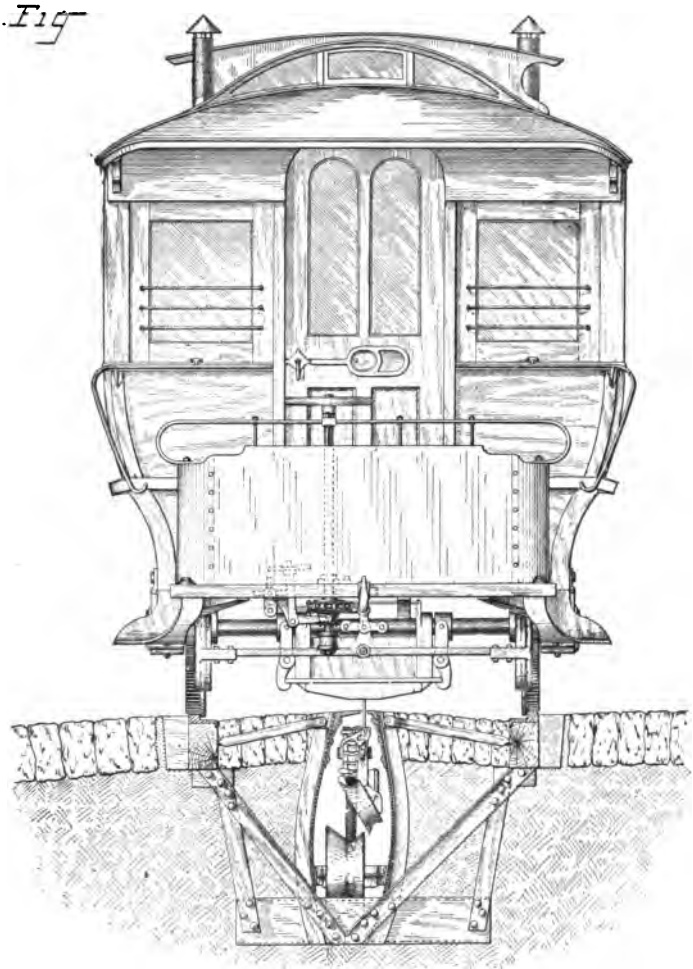


PLATE XIX.

Fig. 1

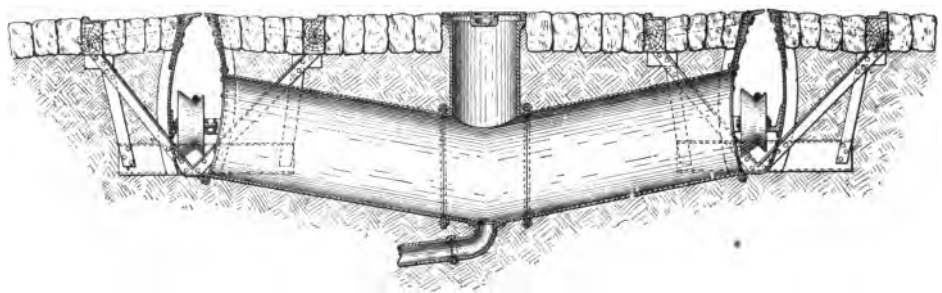


DIAGRAM III.

Fig. 1.

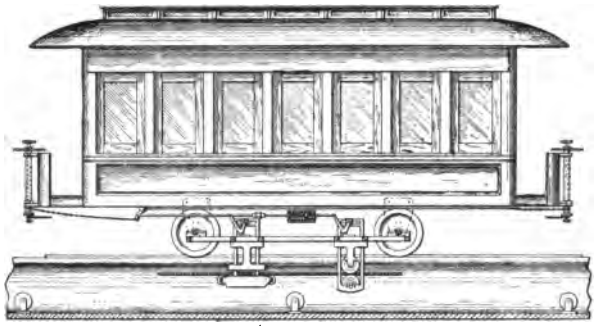


Fig. 3.

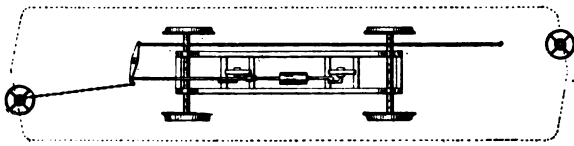


Fig. 2.

Fig. 4

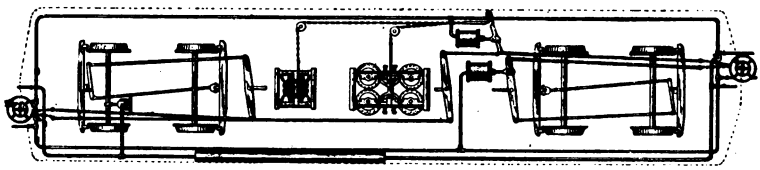


Fig. 5.

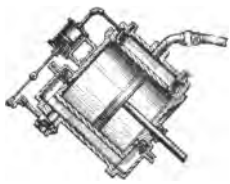


Fig. 11

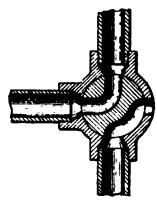
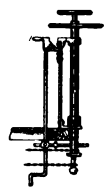


Fig. 12.



SKETCH

OF

THE ROLLER-GRIP SYSTEM

OF

THE RAPID TRANSIT CABLE COMPANY.

(*PATENTED.*)

FIG. 1 of the appended diagram is a side elevation, partly in section, and relates to street-railways where the cable is located in the conduit below the surface. It shows a starting or auxiliary grip (of rollers) with a positive (jaw) grip, which are connected with the same source of operation, and are brought to bear at their proper time upon the cable by a continuous and simple movement; and this same form of grip (but in a horizontal position) is seen in the following figures adapted to heavier cars and trains. The object of the roller grip is to graduate the start of the car or vary its speed with the least wear to the cable, and it so operates that the peripheries of the rollers (between which the cable passes) revolve at the same speed as the moving cable when the car is at rest, and the car progressively starts as the rollers of the grip are gradually retarded by a detaining device, thus producing a differential action which increases the speed of the car proportionately to the gradual decrease in the travel of the peripheries of the grip-rollers, until they cease to revolve, when the car assumes the same speed as the cable; directly following, the jaw-grip takes hold of the cable, and thus serves as a lock to better secure the connection of the car with the cable.

Fig. 2 is a plan of the car-truck and the grips.

Fig. 3 is an enlarged detail section of the roller-grip.

Figs. 4 and 10 are plan views of the pneumatic system for actuating the grips and brakes, either by pressure (with the air-cylinders) or by exhaust (with the diaphragms), as respectively shown. This enables one man to control the grips and brakes of an entire train, and is the means of a simultaneous application of the grips with a perfectly equalized pressure to the cable, which is indispensable where heavy or long trains are in use.

Figs. 5, 11, and 12 are accessories.

Fig. 5 shows a section of the air-pumping cylinder which takes its action from the car-axles, and by pumping into a reservoir supplies the requisite pneumatic force.

Fig. 11 is a section of a four-way cock, made use of in operating the brakes and gripping devices; and Fig. 12 is an elevation of the wheels for acting upon the grip and brake by hand, and also of the lever and connections for the four-way cock.

Figs. 8 and 9 show devices below the car-body for holding the grips and guide-rollers in the proper relation to the tracks, and at the same time supporting them from the car-body, but allowing such car-body to rise and fall without the grip or guide-rollers thereby being raised or lowered; and Fig. 8*a* is a detached view of the counterpoise for the cross-bar carrying the rollers: these enable the employment of larger rollers than could be confined within the car trucks; besides, the preservation of a uniform position of the grips to the curve-pulleys is indispensable to the practicability of operating curves where horizontal roller-grips are employed.

Fig. 6 is a general plan view representing the two track-rails and cable in part of a curved track, also the trucks, running-gear, and grip upon one car and part of another, the platforms of the cars being indicated by dotted lines.

Fig. 7 is a cross-section of the track, showing the relative positions of the guide-rollers on the track and the guide-rollers upon the car when on a curved track.

Fig 13 is a plan view of the junction of a straight and curved track. Fig. 14 is an elevation of one of the guide-rollers upon a

horizontal axis, and a section of the bearing and the guide-wheel upon the vertical shaft. Fig. 16 is a cross-section of the track and elevation of the wheels, and Fig. 15 is an elevation of the wheels adapted to curves having a long radius, Figs. 14, 15, and 16 being in larger size.

Though the principle of the roller-grip, which prevents the slipping of the cable and its consequent wear, is the best, its great deficiency in tractive power, because of the small points of contact of the rollers with the cable, necessitates the employment of a greater number of rollers than can be concentrated in a single motor of dimensions practicable in railway service. The positive (jaw) grip as an adjunct only serves as a lock, for it cannot be applied in starting a train or varying its speed without most injurious frictional wear to the cable, from slipping, when the greater tractive force is required.

Notwithstanding that our pneumatic actuating and other devices materially lessen these defects, it is only possible to do away with complication, and *supply the deficiency, as has been done in our Grip-motors.*

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